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IBM 1311 Disk Storage Drive for IBM 1410 and 7010 Systems

This publication provides detailed information on addressing and organizing 1311 disk storage, instructions, access time, and special features.

IBM 1311 Disk Storage for IBM 1410 Data Processing System

Address comments regarding this publication to:
IBM Corporation, Customer Manuals, Dept. 298, PO Box 390, Poughkeepsie, N.Y.

The IBM 1311 Disk Storage Drive (Figure 1) provides the IBM 1410 and 7010 Data Processing Systems with economical random-access storage of as much data as desired. Data are magnetically recorded on removable and interchangeable disk packs containing six disks. Disk packs enable the customer to store much of his data off-line. This provides the flexibility of a tape system with the advantages of random-access processing.

A disk pack containing as many as 2,980,00 characters can be changed in about two minutes and is interchangeable with disk packs produced by other systems using IBM 1311 disk storage.

Other desirable characteristics are:

1. Low cost per character of storage.
2. Disk pack libraries.
3. Average access time of 150 milliseconds.
4. Table storage for addressing methods using indexing and chaining.
5. Simplification of program scheduling.
6. Ability to dump and recover files into or from core storage rapidly.
7. File security for payroll and other applications.
8. Compatibility with 1401-1311 programs on channel 1. (1401 compatibility is an optional feature on the 7010.)

The first 1311 disk drive on a channel (number 0) must be a Model 5; as many as four Model 2 disk drives can be installed (Figure 2). Both channel 1 and channel 2 can accommodate 1311 disk drives.

The 1311 Model 5 contains circuitry for control of all 1311 disk drives on a system channel. Each 1311 disk drive has an access assembly with a read-write head for each of the ten recording surfaces. The stored program determines which disk drive is to receive or send data. Data can be organized in random or sequential order.

Random Access

Random access is the ability to search only a selected portion of a storage device for desired data. Magnetic tape operations do not have this ability; tape searching must start at the beginning of tape.

Searching is much quicker on random-access disk storage. For example, a large unabridged dictionary stored on tape can be read from a tape unit in about two minutes. A particular word can be found in an average time of one minute. A human can do it faster because he limits his search to an appropriate portion of the dictionary. This random-access principle permits a word and its associated definition or data

Figure 1. IBM 1311 Disk Storage Drives

in 1311 disk storage to be found by the 1410 in less than 1/5 second.

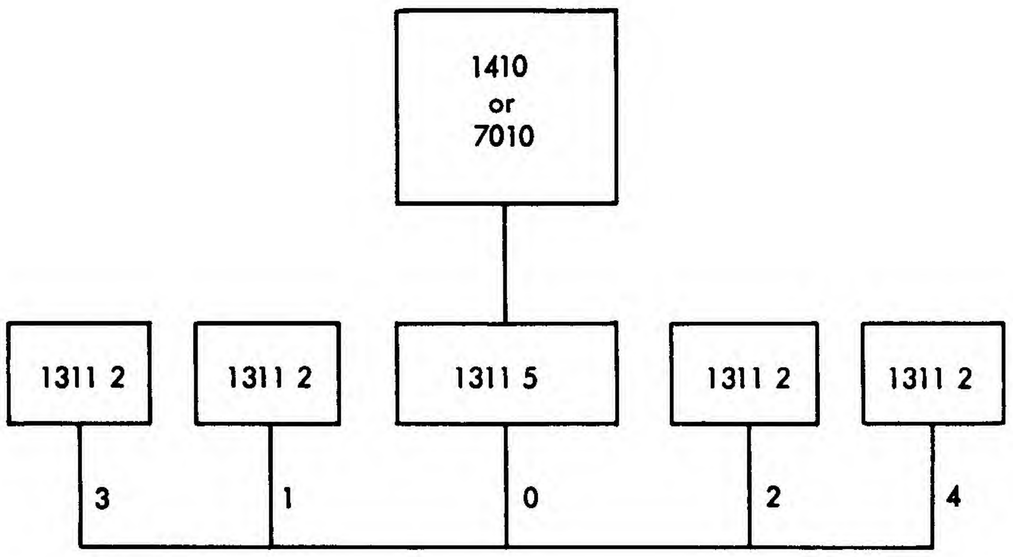


Figure 2. IBM 1410-1311 Configuration

This speed of access to data in the random-access 1311 permits the user to maintain up-to-date files and to make frequent reference to the contained data.

Disk Packs

The portable disk pack is a precision device, designed to meet the close tolerances required for high-speed reading and writing on the 1311. It is 14 inches in diameter and weighs about ten pounds. A disk pack contains six disks coated with a ferromagnetic material. The uppermost and lowermost disk surfaces are not used for recording and are covered by a protective disk. The lower protective disk has holes around its outer edge that regulate light falling on photocells, to provide index and sector timing pulses. An index pulse identifies the beginning of a track.

When a disk pack is not mounted on a disk drive, a bowl-shaped cover (Frontispiece) protects the disks from dust and mechanical damage. A handle for removal is an integral part of the protective cover. The protective cover must be in place before the disk pack can be removed from the drive spindle. The cover cannot be removed when the disk pack is off the drive.

Removing or mounting a disk pack requires no special skill or tools, and can be done in about two minutes. When a disk pack is placed on the drive spindle and tightened, a pack on light turns on. This indicates that the disk pack is properly tightened. The disk pack cover is then removed, the disk drive cover closed, and the drive started.

Caution: Never close the drive cover with the disk pack cover on the disks. Violation of this rule will damage the disk drive.

When the 1311 drive is turned off, or when its covers are opened, the drive rapidly decelerates and the access assembly retracts to a protected position.

A disk pack has ten recording surfaces, each containing 100 concentric tracks divided into twenty sectors of 100 seven-bit characters or 90 eight-bit characters (Figure 3). Sectors are used as record building blocks.

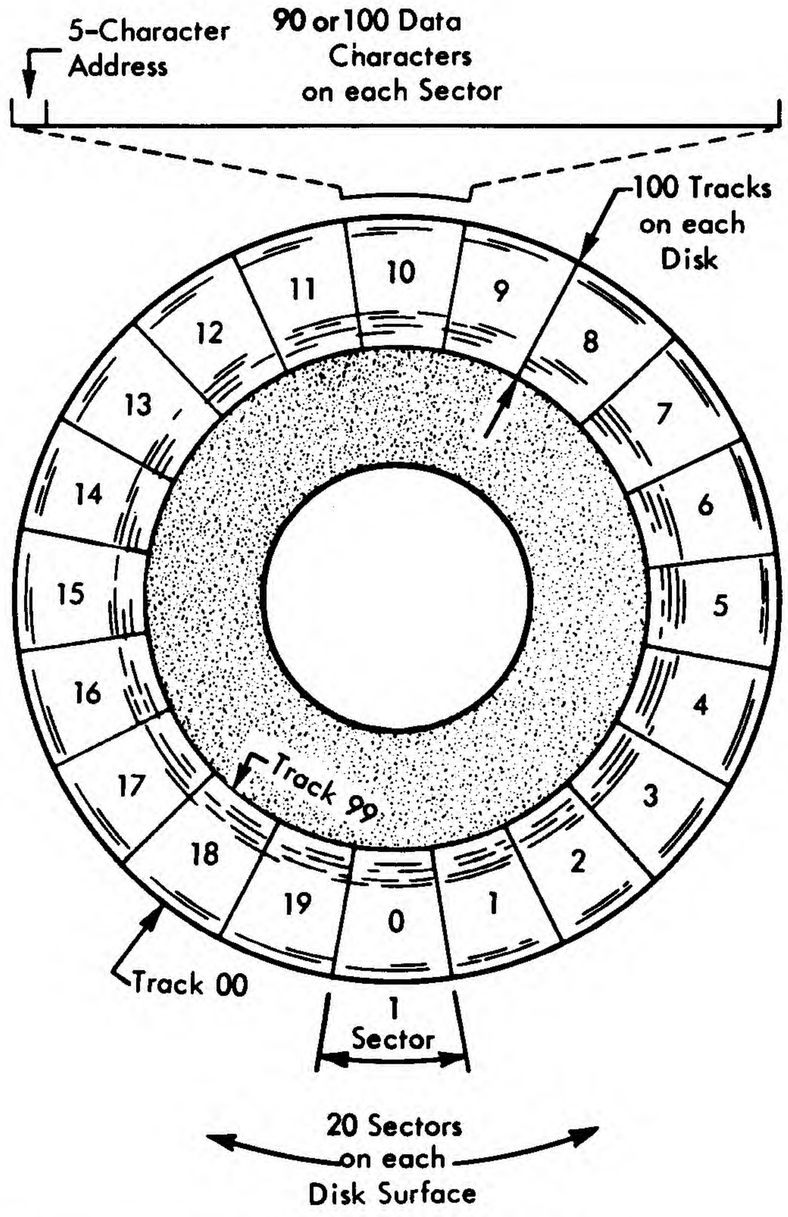


Figure 3. Arrangement of Data on a Disk

Access Assembly

A read-write head is mounted on each of the ten arms of the access assembly (Figure 4). The hydraulically actuated access assembly moves the read-write heads horizontally to any one of the 100 track positions on a disk. No vertical motion occurs.

Each read-write head floats over the moving disks on a thin film of air, providing a highly reliable transfer of a magnetic data recording between head and track.

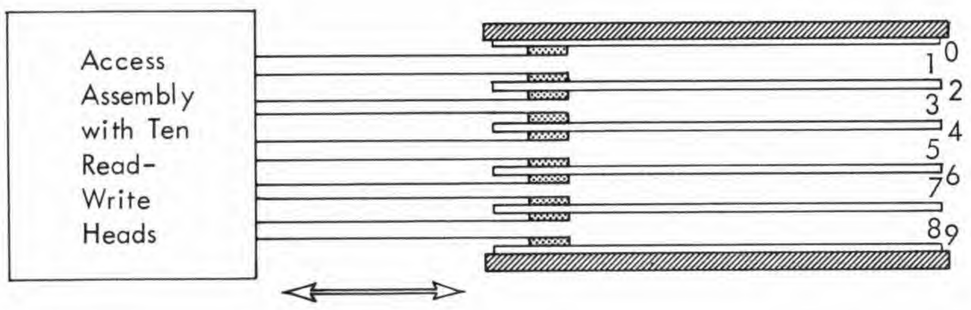


Figure 4. Access Assembly

Data Recording

Data are recorded as magnetized spots on concentric tracks on the recording surfaces. The tracks are accessible for writing or reading by positioning read-write heads between the spinning disks. The disks turn at 1500 revolutions per minute.

Data are recorded as seven-bit BCD characters in move (M) mode or eight-bit BCD characters in load (L) mode. This includes a parity bit position. Parity checking is done by the 1311 Model 5. Load mode characters can carry word marks. Writing destroys previously written information.

Cylinders

In a disk pack, corresponding tracks of each disk surface are physically located one above another. For example, the outermost tracks on the recording surfaces form a cylinder of ten tracks (Figure 5). Each disk pack has 100 cylinders of ten tracks each.

Data in a cylinder of ten vertically aligned tracks may be read or written without motion of the access assembly. Only electronic head switching is necessary to select a particular track within the cylinder. When the proper access location is reached by the access assembly, data in the cylinder are available in 42 milliseconds or less. A cylinder can contain as many as 200 100- or 90-character sectors. A cylinder of sectors may be read sequentially in a multiple record operation. The access assembly can then be moved to the adjacent cylinder and the operation repeated.

Sector Addresses

Each of the 20,000 sectors on a disk pack (20 sectors per track, 100 tracks per surface, and 10 surfaces per disk pack) has a five-digit sector address recorded at the factory. Each of these sector addresses precedes its associated sector on the disk.

IBM 1311 Disk Storage Drives used with a system are numbered 0 through 4. Number 0 must be a 1311 Model 5; drive numbers 1 through 4 must be 1311 Model 2's. Fewer then five may be used. Addresses written on disk packs have the following relationship to the number of the 1311 on which they are written:

Sector Addresses	Disk Drive Number
00000-19999	0
20000-39999	1
40000-59999	2
60000-79999	3
80000-99999	4

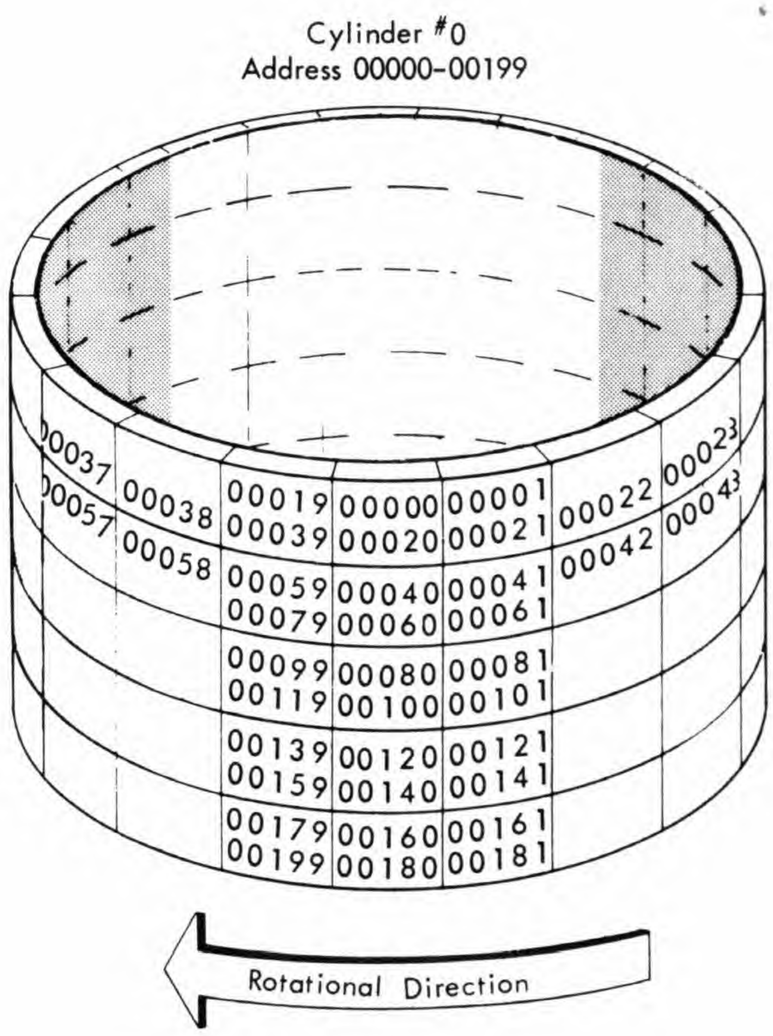
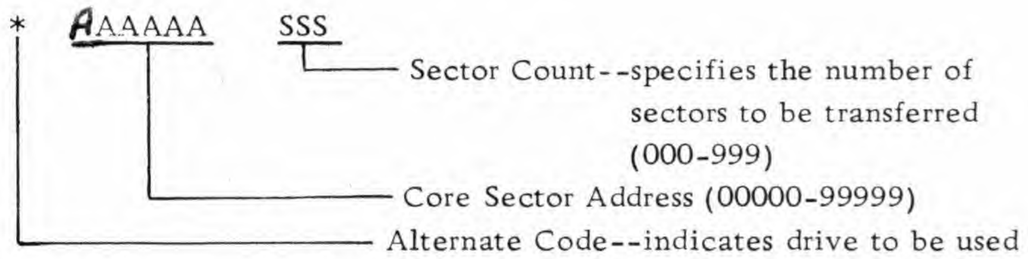


Figure 5. Cylinder Concept

Disk Control Fields

A 1311 disk control field is used by the program to specify the 1311 drive to be used, the sector to be read or written, and the number of sectors that are to be moved. It has the following format:



The alternate code permits reading or writing a disk pack with recorded sector addresses that do not coincide with the sector addresses associated with the number of the disk drive on which the disk pack is mounted:

Alternate Code	Selects Disk Drive
*	As specified by core sector address
0	0
2	1
4	2
6	3
8	4

These numeric alternate codes take precedence over first digit of core sector address

When the disk control field has an asterisk in its high-order position, the core sector address automatically selects the appropriate 1311 disk drive. For example, disk control field *21700 selects disk drive 1. A digit in place of the asterisk can specify an alternate drive; for example, disk control field 421700 selects disk drive 2.

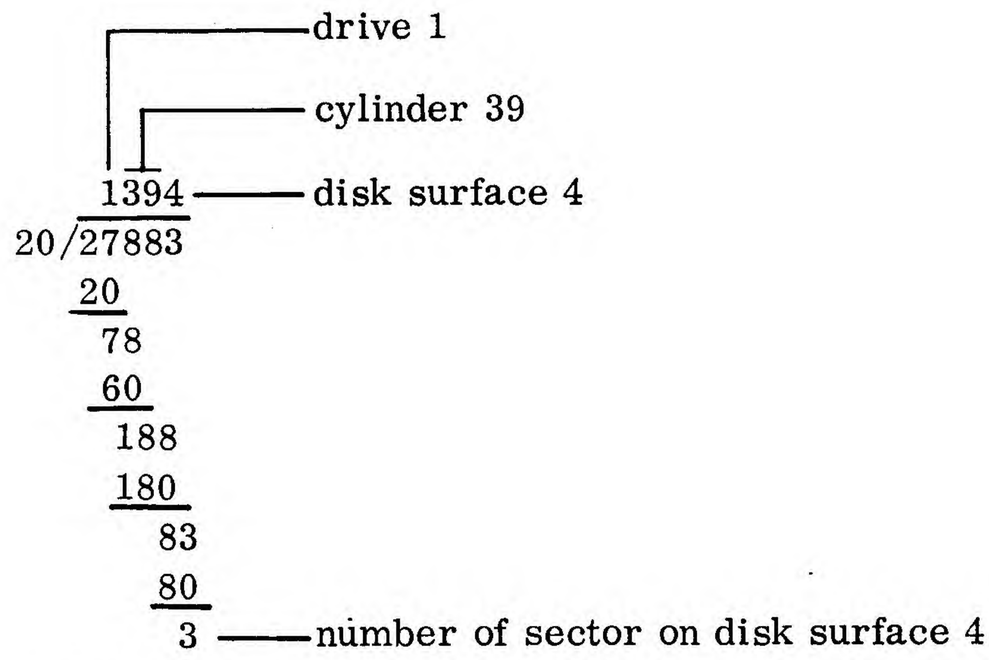
A disk pack with sector addresses ranging from 80,000 to 99,999 may be mounted on drive 0 and read or written with the disk control field 080000xxx. The core sector addresses in core storage must compare equal with the sector addresses on the disk pack. More than one on-line disk pack could have sector addresses in the 80,000 to 99,999 range; the alternate code specifies the desired disk drive. Writing destroys previously written information.

Cylinder Numbers

Drive, cylinder, disk surface, and track sector numbers may be extracted from a disk control field as follows:

Divide the disk control field by 20. The first digit of the quotient is the drive number. The next two digits of the quotient are the cylinder number. The next digit is the disk surface number. The remainder is the sector number (00-19) on the track.

For example, disk control field *27883 specifies sector 3 of disk surface 4 in cylinder 39 on drive 1:



A disk control field specifying an alternate drive overrides the drive number obtained with this procedure.

1311 Model 5 Disk Drive

This unit accommodates a disk pack and has circuitry to control as many as four IBM 1311 Model 2 Disk Drives and to perform a validity check on all data transferred. The five disk drives controlled by the 1311 Model 5 provide on-line random access to as many as 14,900,000 characters of data.

The 1311 Model 5 has a three-digit sector count register that permits one or more sectors to be transferred and is decremented by one for each sector transferred.

The 1311 Model 5 has a five-digit sector address register that contains the address of the next sector to be transferred. It is incremented by one for each sector transferred. (It is not incremented during a track sectors with addresses operation.)

These registers are set by all 1311 operations except the store disk control field operation.

Parity Checking

An odd-bit parity check is performed by the 1311 Model 5 on data transferred to or from 1311 disk storage. A validity check sets the data check channel status indicator in the computer; it may be interrogated by the computer after any disk operation.

Figure 6 shows the format for 1410-1311 disk storage control instructions.

Operation Code

Disk storage operations are initiated by a move (M) or load (L) instruction. The move instruction specifies that data are to be read or written in the seven-bit mode. The load instruction designates eight-bit mode. To insure the proper coding relationship between data in core storage and disk storage, data written with a move instruction must be read with a move instruction. Also, data written by a load instruction must be read with a load instruction. The two modes should not be mixed on the same track.

X-Control Field

The high-order character of the X-control field specifies which data transmission channel is to be used and specifies the overlap or nonoverlap status of the operation.

The second character (F) specifies 1311 disk storage as the input or output device for the operation.

The low-order position specifies which operation is to be performed (Figure 6).

B-Address

The B-address portion of the instruction addresses the high-order position of the disk control field or direct seek address. Data to be written on disk must be preceded in core storage by its disk control field. Data read from disk storage are placed in core storage following their associated disk control field. Disk control fields and data are separated in core storage by a group-mark -- word-mark. A group-mark -- word-mark must appear in the core storage position to the immediate right of the last character of the core storage data field to be written or the data area used to receive data from disk. The core storage location of a disk control field with its related data area (and required group-mark -- word-marks) is determined by the user.

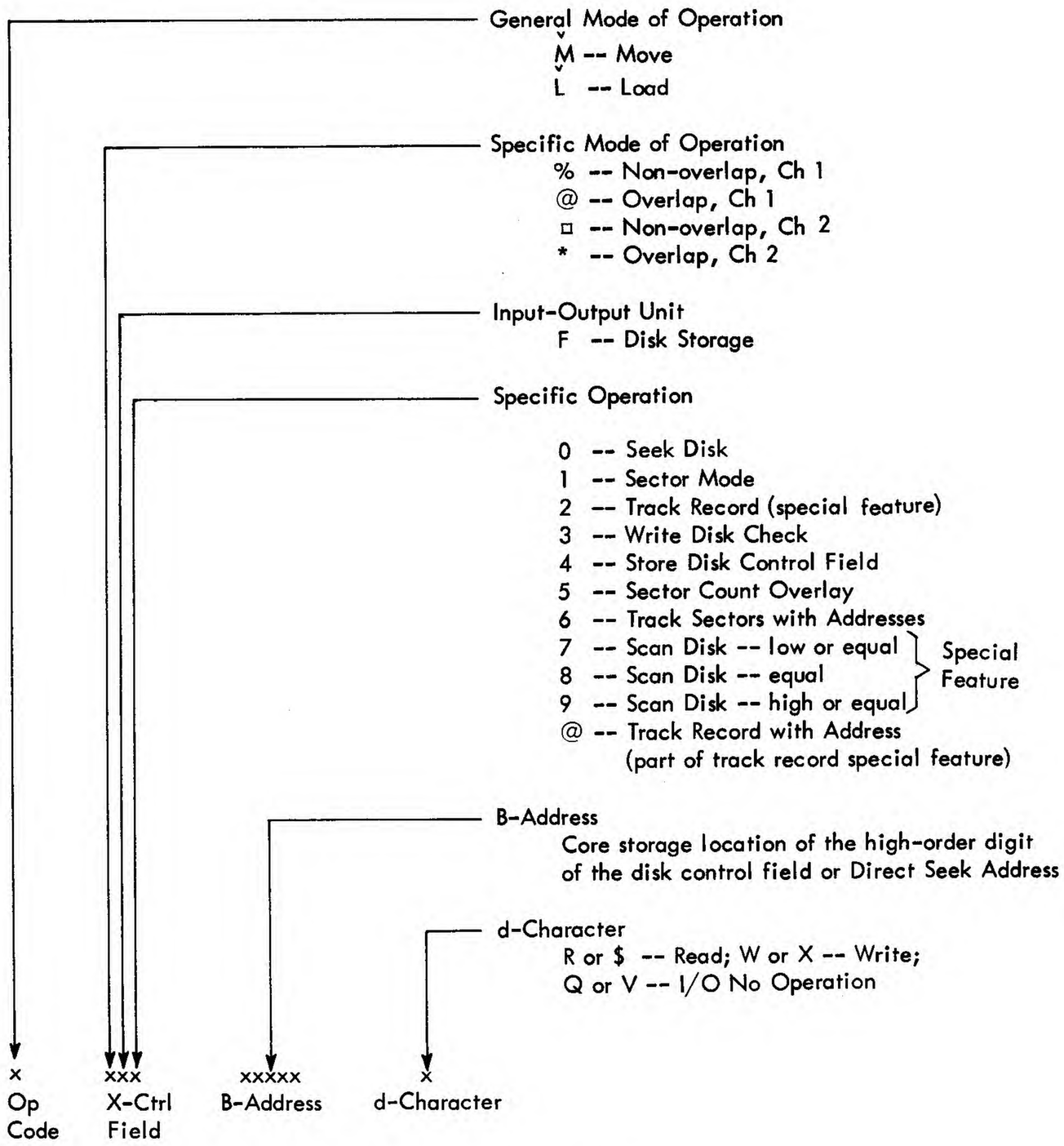


Figure 6. IBM 1410 and 7010 Operation Codes for 1311

d-Character

This portion of the instruction specifies whether a read operation (R or $) or a write operation (W or X) is to take place. Read or write instructions that define the limit of a core storage field or area by a group-mark--word-mark use the R or W d-character.

Read or write instructions that define the limit of a core storage field or area by the end-of-storage indication use the $ or X d-character. Explanation of instructions in this publication assumes the use of the R or W d-character for reading or writing operations. The Q or V d-characters are used with the special feature Priority Processing I-O No-Operation functions; Q indicates input status and V indicates output status.

Seek Disk

Op Code	X-Ctrl Field	B-Address	d-Character
M or L	XF0	xxxxx	R, $, W, or X

This instruction is used to position an access assembly at a particular cylinder of a disk pack. The number of tracks the access assembly is to be moved is specified by the disk control field or direct seek address contained in core storage at the B-address. A group-mark--word-mark follows the disk control field or direct seek address in core storage. Any one of four d-characters (R, $, W, or X) may be used; their presence in the instruction is necessary only to establish a valid instruction length.

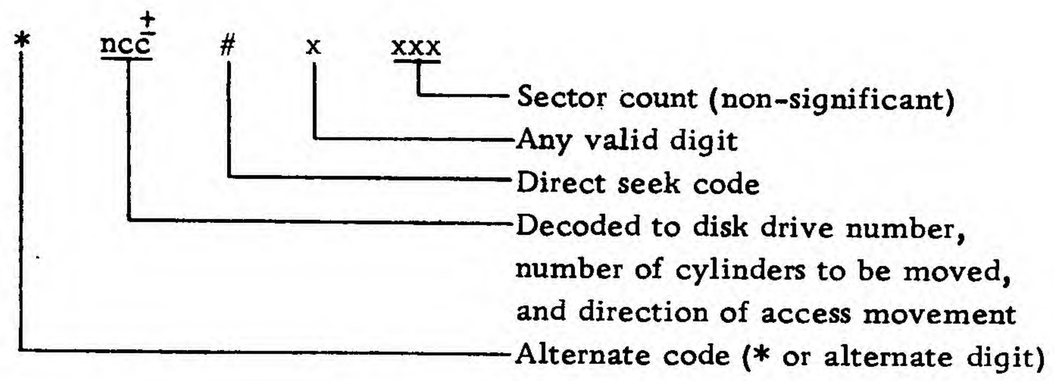
An interrupt on completion of a seek disk operation occurs if the system is equipped with the special priority feature and is in priority alert mode.

Direct Seek

Direct seek operations move the access assembly directly from any position to the desired cylinder. The program must keep track of the location of each access assembly and provide the necessary information for direct seek operations. Specifically, the program must calculate the direction of access movement and the number of cylinders to be moved and generate the direct seek address to be used. Note that a direct seek address specifies a new access assembly location that is always in relation to the present location. If the present location is unknown, a return to home seek (described below) is used to establish a known cylinder location.

Average access time for direct seek operations is 150 milliseconds; maximum access time is about 250 milliseconds.

A direct seek address has a number sign in its fifth digit position to specify a direct seek operation. The direct seek address format is as follows:



The three digits ncc are determined by specifying the drive number and the number of cylinders to be moved and multiplying this number by two.

The sign accompanying the fourth digit of a direct seek address indicates the direction of access motion. A plus sign or the absence of sign causes motion toward the center of the disks. A minus sign causes motion toward the outer edge of the disks. A signed digit appears in Standard Interchange BCD code as an alphameric character; in the following examples $\overset{+}{2}$ appears without sign and $\bar{6}$ appears as O.

Example 1: Direct seek inward one cylinder.

Disk Drive	Direct Seek Address	Direct Seek Address Using Alternate Code
0	*002#0000	0002#0000
1	*202#0000	2002#0000
2	*402#0000	4002#0000
3	*602#0000	6002#0000
4	*802#0000	8002#0000

Example 2: Direct seek outward 53 cylinders.

Disk Drive	Direct Seek Address	Direct Seek Address Using Alternate Code
0	*10O#0000	010O#0000
1	*30O#0000	210O#0000
2	*50O#0000	410O#0000
3	*70O#0000	610O#0000
4	*90O#0000	810O#0000

In both examples, alternate code direct seek addresses use position 1 to specify twice the number of the drive and positions two, three, and four to specify twice the number of cylinders the access assembly is to be moved.

The direct seek address format (Figure 7) is used only for direct seek operations; it is not used to address data for read or write operations.

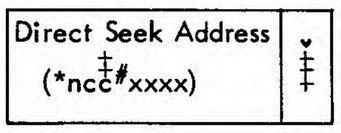


Figure 7. Core Storage Layout--Direct Seek

Return to Home Seek

A seek that causes the access assembly to move outward past cylinder 00 (to Home position) before moving to the desired cylinder is called a return to home seek. A seek instruction with a disk control field (Figure 8) at the B-address causes a return to home seek. Average access time is 250 milliseconds; maximum access time is about 400 milliseconds.

Figure 8. Core Storage Layout--Disk Control Field for Return to Home Seek Disk or Store Disk Control Field Operations

Seek Disk Checking

An unsuccessful seek becomes known when the subsequent read or write operation causes a condition signal. This can indicate that the access assembly is at an unknown location; a return to home seek is necessary to position the access assembly at the desired cylinder.

A typical series of instructions for programming non-overlap seek and subsequent read or write operations is as follows:

```
Branch if I-O Channel Status Indicator ON
Seek Disk
Branch if I-O Channel Status Indicator ON
Read or Write Disk          (Loop until channel
Branch on I-O Channel Busy       not busy)
Branch if I-O Channel Status Indicator ON
```

Seek Overlap

This special feature permits simultaneous seek operations to be programmed for any or all of the disk drives on a channel, thereby achieving a considerable saving in the time required for operations involving more than one disk pack. Direct seek or return to home seek instructions are used.

Sector Mode

Op Code	X-Ctrl Field	B-Address	d-Character
M or L	XF1	xxxxx	R or W

This instruction transfers one or more sectors without sector addresses to or from a 1311 drive. The number of sectors transferred is determined by the sector count of the disk control field.

The disk control field (*AAAAASSS, Figure 9) is sent to the 1311 Model 5 from the computer. The 1311 Model 5 decodes *AAAAA to select the correct disk drive and read-write head, stores the core sector address in its sector address register, stores the sector count in its sector count register, and stores the alternate code position.

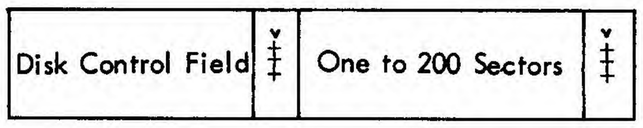


Figure 9. Core Storage Layout--Write or Read Sector Mode

The addressed 1311 then begins a search of the selected surface for a sector address that matches the contents of the sector address register. Sector addresses on the track are compared to the sector address register until a match occurs or until two index pulses have been sensed. An index pulse indicates the beginning of a track. If a match does not occur before two index pulses are sensed, the 1311 Model 5 transmits an end signal and a condition signal to the computer. If a match does occur, data are transferred.

The total number of sectors to be transferred is controlled by the contents of the sector count register. As each sector is transferred, the contents of the sector count register is decremented by one, and the sector address register is incremented by one. The next sector address is then compared with the updated sector address register. When the sector count register becomes 000, the operation terminates.

The incrementing of the sector address register at the end of the last sector on that track causes the next read-write head (for the next track in the cylinder) to be selected. Following the selection of the new read-write head, the first sector address on disk is compared to the sector address register. If it matches, sectors of data continue to be transferred. Upon completion, the 1311 Model 5 sends an end signal to the computer. If any sector address does not match, the 1311 Model 5 transmits an end signal and a condition signal to the computer.

Transfer of data is stopped by:

1. Sensing a group-mark--word-mark in storage.
2. Reducing the sector count register in the 1311 Model 5 to 000.
3. End of cylinder.
4. Failure of the sector address to compare equal with the updated sector count register.

Records less than 90 or 100 characters in length must be filled out with dummy characters to avoid wrong length record and data check indications.

If more sectors are to be transferred when the end of a cylinder is reached, the sector address register is incremented to the first sector address in the next cylinder. This address does not compare equally because the access mechanism has not moved to the new cylinder. The non-compare causes the 1311 Model 5 to send an end signal and a condition signal to the computer. Additional seek and sector instructions are necessary to move the access assembly and transfer the remaining sectors of information in the new cylinder.

Write Disk Check

Op Code	X-Ctrl Field	B-Address	d-Character
M or L	XF3	xxxxx	W or X

The write disk check operation provides a method of checking data previously written on disk. Data recorded on disk storage are read and compared bit for bit by the 1311 Model 5 with the data in core storage previously written on disk.

The type of write check operation (sector mode, track sectors, track record, or sector count overlay) performed depends on the preceding mode of operation; if a sector mode operation preceded the write disk check instruction, it will be a write disk check in sector mode.

An unsuccessful write disk check causes the data check I-O channel status indicator in the computer to be set on.

The Op code, B-address and the d-character for the write disk check instruction must be the same as the operation code, B-address, and d-character of the instruction used to write the data that are to be checked.

Store Disk Control Field

Op Code	X-Ctrl Field	B-Address	d-Character
M or L	XF4	xxxxx	R

This instruction causes the nine characters in the 1311 Model 5 registers (*AAAAASSS) to be transferred to the computer and stored in the location specified by the B-address. This instruction may be used after any 1311 operation. The disk control field format is shown in Figure 8.

Track Sectors with Addresses

Op Code	X-Ctrl Field	B-Address	d-Character
M or L	XF6	xxxxx	R or W

Move mode--2100 characters
Load mode--1900 characters

This instruction transfers a full track of data with sector addresses to or from 1311 disk storage (Figure 10). The core sector address portion of the

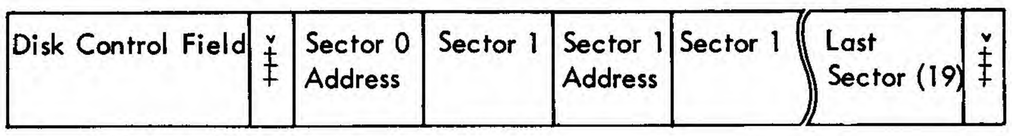


Figure 10. Core Storage Layout--Write or Read Track Sectors with Addresses

disk control field transmitted to the 1311 Model 5 is compared to the sector addresses on the associated track. When a match occurs, the transfer of data is initiated by the next track index pulse. The transfer starts with the first sector address on the selected track. Transfer continues until 20 sectors of addresses and data have been transferred.

This mode of operation permits sector addresses to be read, rewritten, or changed.

For a write track sectors with addresses operation, desired or fictitious records must be supplied for each sector area as it exists in core storage so that sector addresses will be written properly.

The sector count field must be 020 for this operation. The 1311 Model 5 sector address register is not incremented for this operation. If two index pulses are sensed before an address match occurs, an end signal and a condition signal is sent to the computer.

If the group-mark -- word-mark is sensed prior to the disk end-of-track, the wrong length record indicator in the computer is set on and data transfer stops. If disks end-of-track is sensed prior to the group-mark--word-mark in core storage, data transmission stops and the wrong length record indicator is set on.

Note: The write address key light, located on the 1311 Model 5, must be on to write track sectors with addresses.

Track Record with Address

Op Code	X-Ctrl Field	B-Address	d-Character
M or L	XF@	xxxxx	R or W

This special feature instruction transfers 2,980 seven-bit or 2,682 eight-bit characters to or from 1311 disk storage as a single track sector record with sector address (Figure 11). The write address key light must be on for a write track record with address operation.

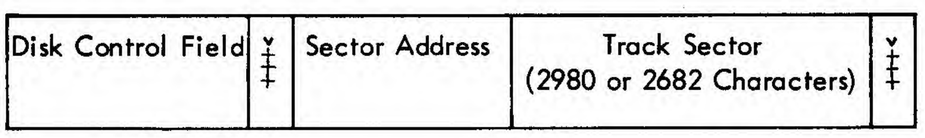


Figure 11. Core Storage Layout--Write or Read Track Record with Address

The sector count specified in the disk control field must be 001. The core sector address for the track record is written in the normal first address position after the index pulse, and may be any sector address in the block of 20 that designate the normal sector addresses on that track. Only one sector address is recorded.

Data transfer begins at index pulse time after a successful sector address compare. If the sector address does not match, a condition signal is sent to the computer.

Tracks adjacent to a track having track record format must also have track record format if they are to be used.

If the group-mark--word-mark is sensed prior to the end-of-track, the wrong length record indicator in the computer is set on and the operation terminates. If the disk end-of-track is sensed prior to the group-mark--word-mark, the wrong length record indicator is set on and the operation stops.

Track Record

Op Code	X-Ctrl Field	B-Address	d-Character
M or L	SF2	xxxxx	R or W

This instruction is part of the track record with address special feature. It functions the same as the track record with address instruction except that the address is not handled (Figure 12). Also, one disk revolution is avoided because the data transfer begins immediately after a successful sector address compare.

Disk Control Field	‡	Track Sector (2980 or 2682 Characters)	‡

Figure 12. Core Storage Layout--Write or Read Track Record

Sector Count Overlay

Op Code	X-Ctrl Field	B-Address	d-Character
M or L	XF5	xxxxx	R or W

Read sector count overlay operations enable data recorded on disk to specify the number of sectors to be transferred (Figure 13). This facilitates operations involving an unknown number of sectors. The sector count must be at least one.

Disk Control Field	‡	xxx	Number of sectors read, less one, is specified by first three positions	‡

Figure 13. Core Storage Layout--Read Sector Count Overlay

The first three digits of the first sector (specifying the additional number of sectors to be read) are automatically placed in the sector count register in the 1311 Model 5 when the first sector is read. This register is decremented by one for each additional sector transferred until it reaches 000 causing the operation to terminate. The first three digits of the first sector are read into computer core storage in the usual manner.

Space must be provided in the B-field for the maximum number of records expected. Fewer records cause a wrong length record indication. A wrong length record indication can be expected when the length of the record is unknown. When operating in the optional overlap mode, the first three characters can be examined and a group-mark--word-mark inserted in core storage before the incoming data fills the field.

A write sector count overlay operation is the same as a sector mode operation with the following difference. As the first three digits of the first record are written on disk, they are also placed in the sector count register in the 1311 Model 5. This allows the first three data characters to specify the additional number of sectors to be written. The number of sectors written is the value of the first three data digits plus one (Figure 14). The sector count in core storage must be at least one.

Disk Control Field	‡	xxx	Number of sectors written after first one is defined by first three positions	‡

Figure 14. Core Storage Layout--Write Sector Count Overlay

Scan Disk

Op Code	X-Ctrl Field	B-Address	d-Character
M or L	XF7 (Low or equal) XF8 (Equal) XF9 (High or equal)	xxxxx	W

This special feature operation scans a specified number of sectors for a compare with a search argument in core storage up to one sector in length (Figure 15). The first sector to be scanned and the number of sectors to be scanned are specified in the disk control field of the scan disk instruction. The search argument follows this disk control field in core storage. Scanning must be done in the same mode (M or L) as that in which the sectors were recorded. Data recorded in track record mode cannot be scanned.

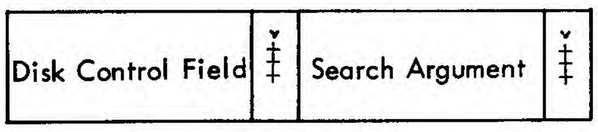


Figure 15. Core Storage Layout--Scan Disk

The argument in core storage is the B-field and the data on the disk pack are the A-field. A word-mark--group-mark placed after the last character in the search argument conserves storage space if the search argument is less than one sector in length. Skip codes ($) in core storage can be used to blank out character positions not used in the search argument:

$$A$123$$456

After a successful sector address compare, the argument from the 1410 is compared character by character with the data from disk storage (skip codes are not compared).

A scan operation terminates when:

1. The desired sector is found. The sector count register in the 1311 Model 5 may or may not have reached 000.
2. End of cylinder occurs before completion of the scan. This causes a condition signal to the computer; the sector count register will not contain 000.
3. A scan is completed without finding the desired data. The sector count register will be 000.

After a successful scan, the address of the sector that satisfies the search argument is in the sector address register where it is available to a store disk control field operation. The result of the scan is learned by testing the computer compare indicators (Hi-Lo-Eq) with the appropriate branch if indicator on instruction.

High indicates that the B-field (argument) is greater than the A-field (disk storage). Low indicates that the B-field is less than the A-field.

I-O No Operation

Op Code	X-Ctrl Field	B-Address	d-Character
M or L	xFx	xxxxx	Q or V

This instruction is used only on the 7010 or on a 1410 system equipped with the priority processing special feature. Its primary purpose is to set the I-O channel status indicators for an I-O unit, so that the status of the unit can be tested by a branch if I-O channel status indicator on instruction -- R(I)d or X(I)d. No data transfer occurs with this instruction.

For example, assume that a 1311 Model 5 with the seek overlap special feature has issued seek instructions to several access assemblies. The first access assembly to reach its destination will cause an interrupt to the system. It is necessary to determine which access assembly caused the interrupt.

The I-O no operation disk control field selects a particular access assembly. A branch on busy instruction (R(I)d) is used to determine if that access assembly is busy. If the access assembly is in motion, a busy condition will result. If the access assembly is not in motion, a busy condition will not result (seek completed) and it can be assumed that the access assembly addressed is the one that caused the interrupt. Each of the moved access assemblies can be tested in this manner.

The seek complete signal that caused the interrupt is terminated by a read, write, or I-O no operation instruction that addresses the access assembly that caused the signal.

When the I-O no operation instruction is being used to set the I-O channel status indicators, the Op code can be M or L, the units position of the X-control field can be any valid character, and the d-character can be either Q or V. Q is used for input status; V is used for output status.

Details of I-O no operation functions are given in the IBM 1410 Data Processing System Priority Feature Bulletin, Form G22-6694.

CHANNEL STATUS INDICATORS

The input-output channel status indicators in the computer that can be set by a 1311 disk storage operation are:

Indicator	Description	d-Character Control Bit
Not Ready	Unsafe condition 1311 power off 1311 disconnected Drive motor off (disk pack being changed) Write address key light in wrong position	1
Busy	Any access in motion (without seek overlap) Addressed access in motion (with seek overlap)	2
Data Check	Parity check Write disk check	4
Condition	No record found Absence of sector address match subsequent to sector address match	8
No Transfer	No read or write operation performed	A
Wrong Length Record	Short or long length record	B

DISK PACK HANDLING AND STORAGE

The disk pack is a precision device, designed to meet the extremely close tolerances required for high-speed reading and writing on the 1311. It should be handled with care.

Disk packs should be stored horizontally, one high. They should never be stacked on top of each other or rolled on their sides. Damage to the cover will impair its primary function of dust protection.

Disk packs should be stored in an area as dust-free as the system room. The temperature of the storage area should be the same as that of the system room. A storage temperature 10 degrees greater or lesser than the system room will require disk packs to be conditioned to the temperature of the system room before use.

Operating Keys and Lights (Figure 16)

Start-Stop Key: Placing this key in the start position applies power to the disk drive and establishes the unit in ready condition. Placing this key in the stop position drops the ready condition, removes power from the drive motor, and causes the access assembly to retract. In this way, the drive is conditioned for disk pack replacement without affecting operation of the system or of other drives under control of the program.

Ready Light: The ready light indicates that the drive is prepared to operate under system control.

Figure 16. IBM 1311 Model 5 Keys and Lights

Pack On Light: This light indicates that the disk pack has been properly tightened on the drive spindle. No attempt should be made to remove the disk pack cover unless this light is on. The disk drive cover will damage the disk drive if closed on a disk pack cover.

Write Address Key Light (#0 Drive Only): This key light indicates whether or not disk write operations will be in address mode. When the light is on, address operations and read operations can be performed. It must be set to agree with the write instruction used in the program.

TIMING

Timing considerations for 1311 sector operations include:

Access motion time	150 ms (average)
Head select delay	2 ms
Rotational delay	20 ms (average)
Write or read	2 ms (each sector)
Write disk check	2 ms (each sector)

Access motion time is the time required to move the access assembly to the desired cylinder. Access assembly motion has two rates of speed: movement within ten cylinders is at a rate of 2 inches per second; additional movement is at the rate of 16 inches per second.

After a seek instruction has been issued, processing can continue until another disk storage instruction is issued. The length of the seek depends on the total number of cylinders that must be passed during the seek operation.

Figure 17 provides approximate direct seek access times.

Figure 18 provides approximate return to home seek access times.

Head select delay is the time required for the initial switching of the read-write head circuitry for the desired track. Head switching from track to track within a cylinder during an operation does not incur a head select delay.

Rotational delay is the time required for the moving disk to position the desired record at the selected read-write head (40 ms maximum).

Two milliseconds are required for the disk to move one sector length under the read-write head for write, read, or write disk check operations.

Cylinders Traveled	Time in Milliseconds
1	54
2	67
3	80
4	90
5	105
6	115
7	130
8	140
9	155
10	165
20	130
30	137
40	154
50	170
60	185
70	202
80	217
90	235
99	248

Figure 17. Direct Seek Access Times

To ↓ / From	00	09	19	29	39	49	59	69	79	89	99
00	75	88	101	114	127	140	153	167	179	192	204
09	175	188	201	214	227	240	253	267	279	292	304
19	143	156	169	182	195	208	221	235	247	260	272
29	153	166	179	192	205	218	231	245	257	270	282
39	168	181	194	207	220	233	246	260	272	285	297
49	184	197	210	223	236	249	262	276	288	301	313
59	200	213	226	239	252	265	278	292	304	317	329
69	215	228	241	254	267	280	293	307	319	332	344
79	232	245	258	271	284	297	310	324	336	349	361
89	248	261	274	287	300	313	326	340	352	365	377
99	263	276	289	302	315	328	345	355	367	380	392

Figure 18. Return to Home Seek Access Times

SUMMARY OF 1311 CHARACTERISTICS

	Move Mode* Seven-Bit Characters	Load Mode* Eight-Bit Characters
Maximum characters per track in sector mode	2,000	1,800
Maximum capacity per access setting in sector mode	20,000	18,000
Maximum capacity per disk pack in sector mode	2,000,000	1,800,000
Maximum capacity per single channel system in sector mode (five disk packs)	10,000,000	9,000,000
Maximum capacity for two channel system in sector mode (ten disk packs)	20,000,000	18,000,000
Maximum data characters per track in track record mode (special feature)	2,980	2,682
Maximum capacity per disk pack in track record mode	2,980,000	2,682,000
Maximum capacity per single channel system in track record mode (five disk packs)	14,900,000	13,410,000
Maximum capacity per two channel system in track record mode (ten disk packs)	29,800,000	26,820,000
Average access time, direct seek	150 milliseconds	
Average access time, return to home seek	250 milliseconds	
Average rotational delay	20 milliseconds	

* Data are recorded as seven-bit BCD characters in move (M) mode or eight-bit BCD characters in load (L) mode. This includes a parity bit position. Load mode characters can carry a word mark.

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